AdBudgetOptimizer

Standard Edition

Version 1.1

User Manual

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I Introduction

1. Budget Allocation in Online Advertising Campaigns

AdBudgetOptimizer is a program for determining optimal budget allocation strategies in bid-based pay-per-click (PPC) advertising campaigns.

In PPC campaigns, advertisers select keyword phrases for which they want to show ads on content pages or search engine result pages. They then pay for each click they receive through their ads.

In order for an ad to get displayed, the advertiser beforehand needs to specify the highest price per click he or she is willing to pay (hereinafter: "maximal cost-per-click bid", abbreviated "max-CPC-bid"). The higher the bid, the better the placement on the target page and the higher the likelihood for the ad being clicked on, leading to a higher number of total clicks per day. The actual price for a received click is usually calculated by taking into account the bid of the next highest bidder, therefore it is mostly lower than the bid value, and it may be different for each individual click.

The advertiser can specify a budget for the total cost of a keyword per day. If the budget is exhausted, no more ads are shown for that keyword, thereby limiting the total number of received clicks per day. Thus, the total number of clicks per day and the average cost per click depend on the max-CPC-bid value (how much to spend at most for each click) as well as on the daily budget (how much to spend at most for all clicks together).

The expected value of the total cost per keyword and day can be calculated by multiplying the expected number of clicks by the expected value of the average cost per click. Advertising networks usually provide tools for estimating how many clicks per day a given max-CPC-bid value will generate and how much each click will cost on average.

To determine appropriate max-CPC-bid and budget values for a keyword, the advertiser needs to take into account how much earnings each click generates on average.

Estimates for earnings per click are usually derived from historical data and may e.g. be calculated by dividing total profit resulting from a single keyword (not taking into account PPC advertising cost) by the total number of clicks received through that keyword.

For a given max-CPC-bid value, expected profit per click can be calculated as the difference between average earnings and average cost per click. For one single keyword, it is optimal to select a max-CPC-bid value for which daily profit, i.e. the number of clicks times profit per click, is maximal.

However, simultaneously determining optimal max-CPC-bid values for multiple keywords becomes a challenging optimization problem, if total cost are constrained by a budget.

AdBudgetOptimizer determines solutions for this problem based on the optimization model outlined in the next section.

2. Mathematical Model

The optimization problem consists of selecting max-CPC-bid values for all keywords in such a way that total profit is maximized.

Since a max-CPC-bid value corresponds to a particular number of clicks per day as well as to a particular average-cost-per-click value, expected cost and earnings per day can be calculated unambiguously for every given bid value. Consequently, the optimization problem of selecting optimal bid values can be reformulated as one of selecting optimal cost/profit combinations. The key idea is to construct an approximation of the feasible region of cost/profit combinations from a finite set of "traffic estimates", where a traffic estimate means a combination of a max-CPC-bid value, a corresponding number of clicks, and an average-cost-per-click value.

Formally, the optimization model represents an advertising campaign, which consists of n keywords and an overall budget $C^{\max}$. For each keyword i, an earnings-per-click value e_i and a set of m_i traffic estimates must be given. Each traffic estimate j consists of a max-CPC-bid value b_{ij} and corresponding values for the number of clicks x_{ij} and for the average cost per click a_{ij}.

The goal is to set a max-CPC-bid value B_i and a budget C_i for each keyword i, so that overall profit P is maximized. The budget value C_i corresponds to the estimated cost of all clicks received through keyword i.

For each keyword i, cost C_i and earnings E_i can be calculated as:

$$C_i = \sum_{j=1}^{m_i} a_{ij} x_{ij} v_{ij} \qquad \text{for } i = 1, \ldots, n \tag{1}$$

$$E_i = \sum_{j=1}^{m_i} e_i x_{ij} v_{ij} \qquad \text{for } i = 1, \ldots, n \tag{2}$$

The variables v_{ij} are auxiliaries, whose values correspond to the fractions by which each traffic estimate j is represented in the solution of keyword i. The following constraints apply:

$$0 \leq v_{ij} \leq 1 \qquad \text{for } i = 1, \ldots, n, j = 1, \ldots, m_i \tag{3}$$

$$\sum_{j=1}^{m_i} v_{ij} = 1 \qquad \text{for } i = 1, \ldots, n \tag{4}$$

Profit per keyword can be calculated as:

$$P_i = E_i - C_i \qquad \text{for } i = 1, \ldots, n \tag{5}$$

Aggregate values of campaign profit and cost can be calculated as:

$$P^{\text{total}} = \sum_{i=1}^{n} P_i \tag{6}$$

$$C^{\text{total}} = \sum_{i=1}^{n} C_i \tag{7}$$

Finally, total cost C^{total} must not exceed the overall budget:

$$C^{\text{total}} \leq C^{\text{max}} \tag{8}$$

The optimization probem can then be formulated as

$$\begin{gathered} \max P^{\text{total}} \\ \text{subject to (1) to (8)} \end{gathered}$$

After a solution is determined, max-CPC-bid values B_i can be calculated as

$$B_i = \sum_{j=1}^{m_i} v_{ij} b_{ij} \qquad \text{for } i = 1, \ldots, n$$

II Using AdBudgetOptimizer

1. Installation

Installing on Windows

The installation can be started by double-clicking on the icon of the file you downloaded when purchasing the software. A setup wizard will lead you through the installation process. You do not need administrative privileges to install the software.

The installer will create an "AdBudgetOptimizer" group in the Windows "Start" menu, which allows you to launch the application. The group also contains a shortcut to uninstall the software.

Installing on Linux

The software can be installed by simply extracting the contents of the archive file you downloaded when purchasing the software.

First, copy or move the archive file from its download location to the directory into which the program shall be installed. Then, in a terminal window, change to that directory, e.g.

```
cd ~/myprograms
```

You can then extract the contents of the archive file:

```
tar -xzvf AdBudgetOptimizer-1.1.tar.gz
```

The directory now contains a subfolder “AdBudgetOptimizer”.

To launch the program, change to this subfolder and run the executable:

```
cd AdBudgetOptimizer/
./adbudgetoptimizer
```

You can uninstall the software by simply removing the “AdBudgetOptimizer” directory.

2. Main elements of the user interface

The main elements of the user interface are shown in Figure 1. At the top of the window, the Title bar Ⓐ shows the file name of the currently active campaign tab (see below). The Menu bar Ⓑ is located directly below the Title bar. When you click on a menu label, a dropdown menu with various commands will appear.

AdBudgetOptimizer is a single window application, though it is possible to work with multiple campaigns at the same time by using tabs. The Tab bar Ⓒ, which is located just below

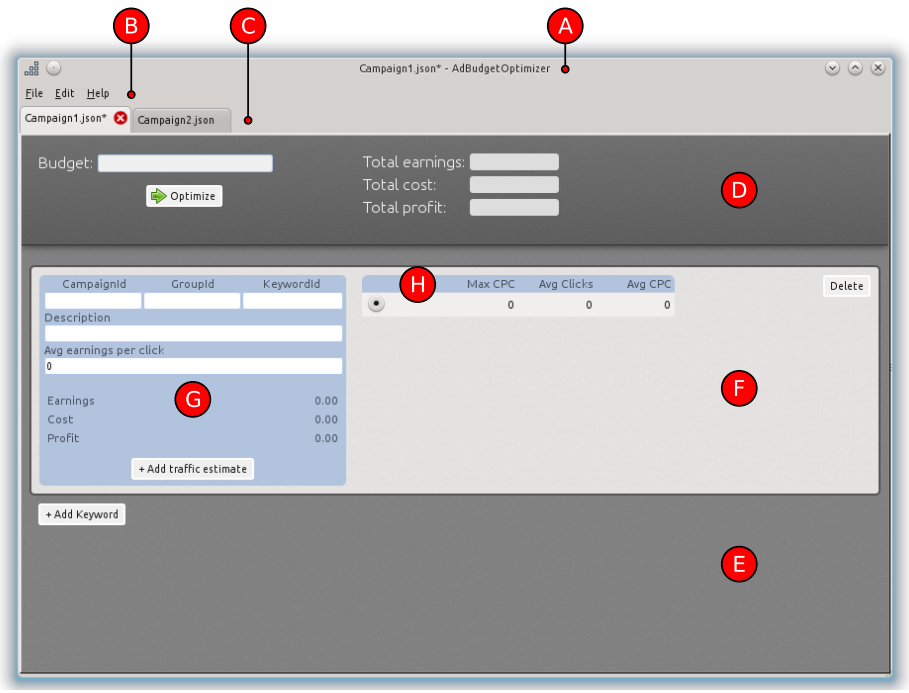

Figure 1: Main elements of the user interface

the Menu bar, allows switching between different campaign tabs. A tab can be activated by clicking on it. A campaign contains all the keywords which are to be optimized together. Each campaign is represented by a single tab in the user interface, and by a single file in the file system. A campaign tab is divided into a header section D, with information about the whole campaign, and a body section E for displaying panels F with information about individual keywords.

The header section of a campaign tab contains an input field for the total campaign budget, a button for starting the optimization, and three fields for the overall result values total cost, total earnings and total profit.

Each keyword panel contains a header E and, to the right of the header, a list of traffic estimates H.

3. Working with campaign files and tabs

Create a new campaign

To create a new campaign, select **New** in the File menu. A new tab will appear in the Tab bar.

Save a campaign

To save a campaign to a file, select **Save** in the File menu. If the campaign has not been saved before, you will be prompted to enter a file name and to choose a location for the file. If the file has been saved previously, **Save** writes the changes to the same file without any further interaction. You can always save to a different file by selecting **Save as** in the File menu. This command will open the file dialog.

Open a campaign file

To open an existing campaign file, select **Open** in the File menu. You can then choose a file with the file dialog and open it by clicking on **Open**. The campaign file will be displayed in a new tab.

Close a campaign file

To close the currently active campaign tab, select **Close** in the File menu or click the red close button on the right side of the tab. If the tab contains unsaved changes, you will be asked if the modifications should be saved or discarded.

4. Editing campaign data

Set a campaign budget

You can enter the overall campaign budget into the text field labeled “Budget” within the header in the campaign tab panel. If this field is left blank, or if you enter a value less than or equal to 0, the budget is assumed to be unlimited.

Add or remove keywords to/from a campaign

Each keyword in a campaign is represented by a keyword panel. To add a new keyword, click the **Add Keyword** button within the campaign tab body. To remove a keyword, click the **Delete** button in the top right corner of the keyword panel.

5. Editing keyword data

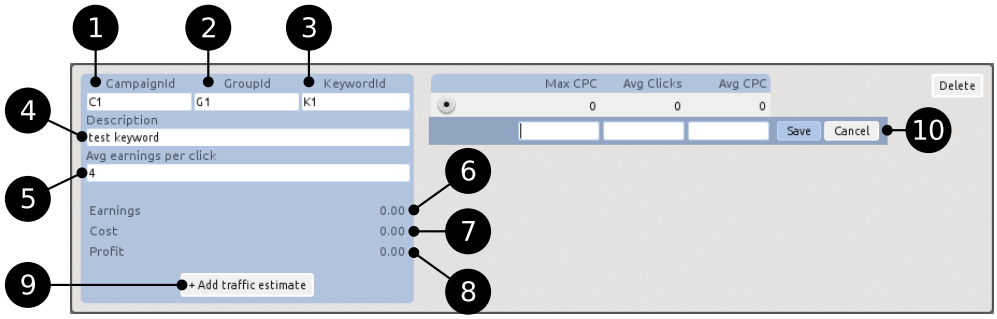

Figure 2: Keyword panel

Edit keyword parameters

The keyword panel header section contains five fields for entering keyword specific data. The first three fields can be used to identify the keyword. You can enter an advertising campaign ID in ❶ (see Figure 2), a keyword group ID in ❷ and/or a keyword ID in ❸. The field ❹ is used for the actual textual description of the keyword. None of the aformentioned fields requires special format, and they may also be left blank. The mandatory field ❺ stores the earnings-per-click-value of the keyword.

Additionally, the header section contains three read-only fields which display the expected earnings ❻, cost ❼ and profit ❽ of the keyword. These values are calculated by taking into account the currently selected max-CPC-bid-value (see below).

Add a traffic estimate

In the list of traffic estimates, to the right of the header section, each row represents a single estimate consisting of a max-CPC-bid-value, an average-CPC-value and a corresponding number of clicks.

Initially, the list contains only one entry with a max-CPC-bid-value of 0. Selecting this entry means that no budget is assigned to the keyword, i.e. it will not be used at all.

To add a new traffic estimate, click the **Add traffic estimate** button ❾ at the bottom of the keyword panel header. You can then enter the three required values into the respective fields of the popup dialog ❿ at the bottom of the list. Click the **Save** button when done, or **Cancel** to discard the entry.

Edit or delete a traffic estimate

To change the values of a traffic estimate, click its corresponding ⋯ (edit) button ⓫. You can then modify the values in the popup dialog ⓬. Click the **Save** button when done, or **Cancel**

to discard the changes. To remove an estimate, click the **Delete** button on the left hand side of the popup dialog.

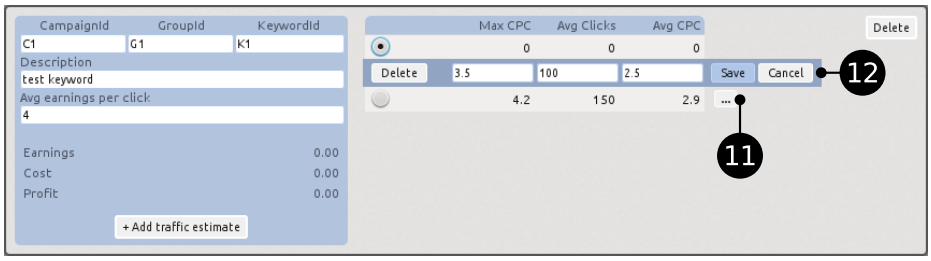

Figure 3: Editing traffic estimates

Select a bid value manually

To select a max-CPC-bid-value for a keyword manually, click the corresponding radio button in the row of the traffic estimate. The values of cost, earnings and profit in the keyword header section, as well as the aggregate values in the campaign header section, will be updated accordingly.

6. Optimizing a campaign

To start the optimization, click the **Optimize** button in the campaign header section.

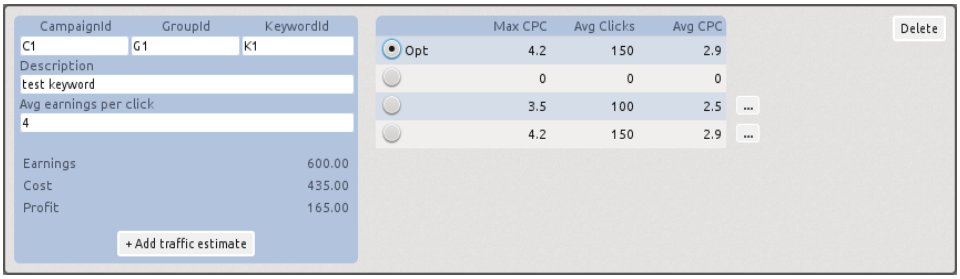

Figure 4: Optimal traffic estimate

After the optimization has completed, a row for the optimal max-CPC-bid value will be inserted at the top of the list of traffic estimates in each keyword panel.

Furthermore, the values of cost, earnings and profit per keyword in the keyword panel header section, as well as the aggregate values in the campaign header section, will be updated according to the optimal solution.

Note that the solution for a keyword always consists of both the max-cpc-bid-value and the cost-value.

You can continue to modify the campaign after the optimization, and restart the optimization at any time.

7. Exporting solutions

To export the current solution, select **Export Solution** in the File menu. You will be prompted to enter a name and to select a location for the solution file. The file format is described in the next section.

8. File Formats

Campaign Files

Campaign files are saved in JSON format. A campaign consists of a single top-level JSON object:

```
{
  "keywords": [ KEYWORD+ ] | [],
  "budget": float
}
```

A campaign object has two fields: a `budget` field of type float, and a `keywords` field, which stores an array of keyword objects.

Each keyword object has the following structure:

```
KEYWORD := {
    "campaign_id": string,
    "adgroup_id": string,
    "keyword_id": string,
    "description": string,
    "avg_epc": float,
    "cost": float,
    "earnings": float,
    "profit": float,
    "clicks": float,
    "max_cpc": float,
    "estimates": [ TRAFFIC_ESTIMATE+ ] | [],
    "optimal_estimate": TRAFFIC_ESTIMATE | null,
    "active": int
}
```

The fields `campaign_id`, `adgroup_id`, `keyword_id` and `description` contain the respective values which identify the keyword, and the field `av_epc` is used to store the value of the average earnings per click.

The fields `cost`, `earnings`, `profit`, `clicks` and `max_cpc` store the respective result values of the corresponding keyword.

The list of user-provided traffic estimates is stored as an array of traffic estimate objects in the field `estimates`. The optimal estimate ist stored separately in `optimal_estimate`.

The integer value in `active` indicates which traffic estimate is currently selected. A value of -1 represents the optimal estimate, a value of 0 stands for the estimate with a max-CPC-bid value of zero, and a value greater than or equal to 1 corresponds to the index of one of the user-provided traffic estimates in the array field `estimates`.

A traffic estimate object consists of three float fields:

```
TRAFFIC_ESTIMATE := {
      "max_cpc": float,
      "avg_clicks": float,
      "avg_cpc": float
  }
```

Solution Files

Solution files are saved in semicolon delimited CSV format with the following columns:

1. CampaignId
2. GroupId
3. KeywordId
4. Description
5. Cost
6. Earnings
7. Profit
8. Clicks
9. Max CPC

The first row contains the columns names, and each subsequent row represents the solution of a single keyword.